Protected Instream Flow Studies and Water Management Plan for the Souhegan River Designated Reach

University of New Hampshire
University of Massachusetts
Normandeau Associates, Inc.

Work Tasks

- 1 - Identification and Draft List of IPUOCR Entities
- 2 - Assessment of Well Withdrawal Impacts on Surface Water
- 3 - On-Stream Survey
- 4 - Report Describing IPUOCR Entities and Proposed PISF Methods
- 5 - PISF Assessments and Proposed PISF Report
- 6 - PISF Public Hearing
- 7 - PISF Final Report
- 8 - Assessment of Water Use with the Established PISF
- 9 - Development of WMP Sub-plans
- 10 - Proposed WMP
- 11 - WMP Public Hearing
- 12 - WMP for the Souhegan River Designated Reach

Task 1. Identification and Draft List of IPUOCR Entities

Category	Entity	Location	Flow Dep. Yes, No	Critical Flows High, Avg., Low	Critical Life Stage	Critical Season Sp Su F W	Method of Assessment
Recreation	Boating		Yes	High, Ave		Sp, F	Determine flow needs through observation and boater interviews
Storage	SOUHEGAN RIVER DAM - New Ipswich	NEW IPSWICH	No				
	WATERLOOM POND DAM-New Ipswich	NEW IPSWICH	No				
	OTIS DAM-Greenville	GREENVILLE	No				
	SOUHEGAN RIVER DAM-Wilton	WILTON	No				
	SOUHEGAN RIVER III DAM	GREENVILLE	No				
	SOUHEGAN RIVER	GREENVILLE	No				
	SOUHEGAN RIVER III DAM	WILTON	No				
	SOUHEGAN RIVER DAM	WILTON	No				
	PINE VALLEY MILL DAM	WILTON	No				
	GOLDMAN DAM	MILFORD	No				
	MCLANE DAM	MILFORD	No				
	MERRIMACK VILLAGE DAM	MERRIMACK	No				
Fishing			Yes	Low	Adults	Su	mesohabsim

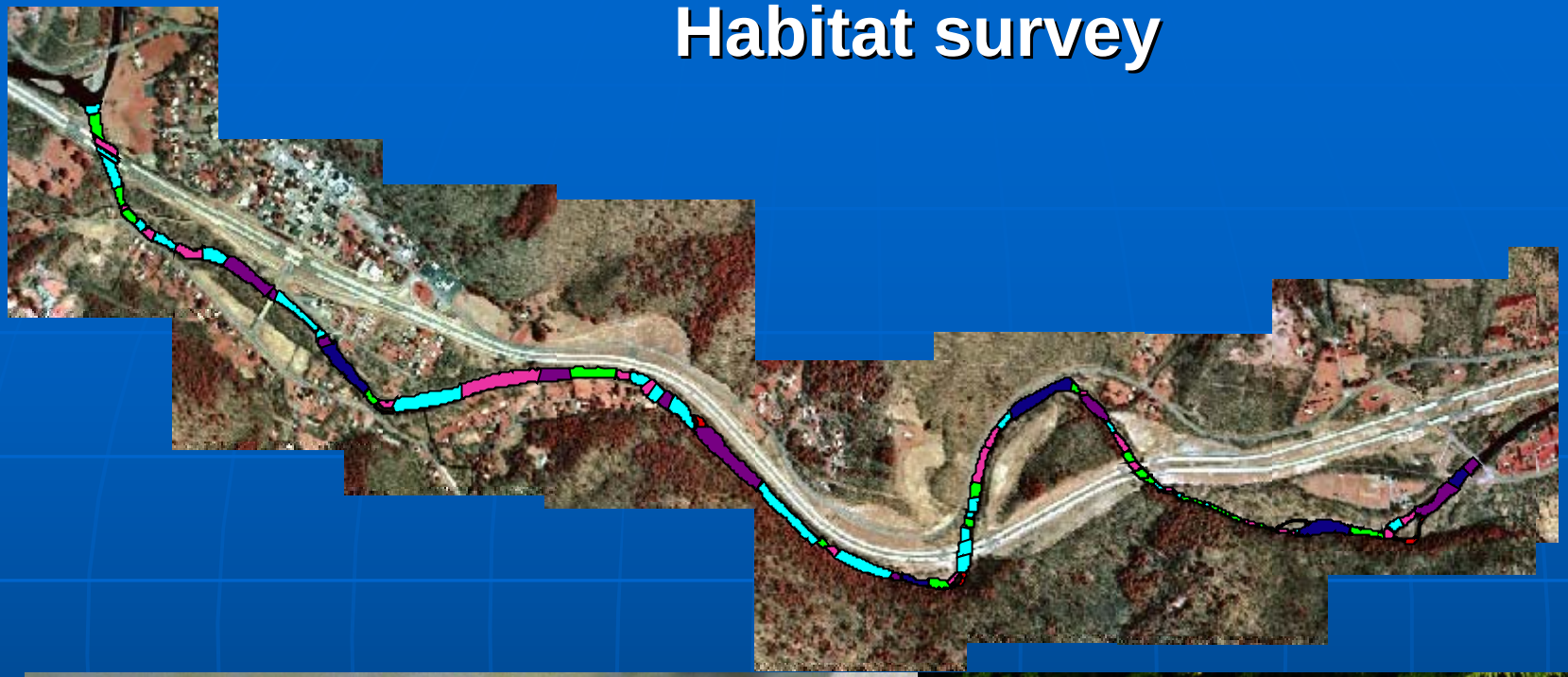
Task 2. Assessment of Well Withdrawal Impacts on Surface Water

Determine the potential reduction of streamflow due to ground water withdrawals

Task 3: On-Stream Survey

Field verify IPUOCR information

Habitat survey

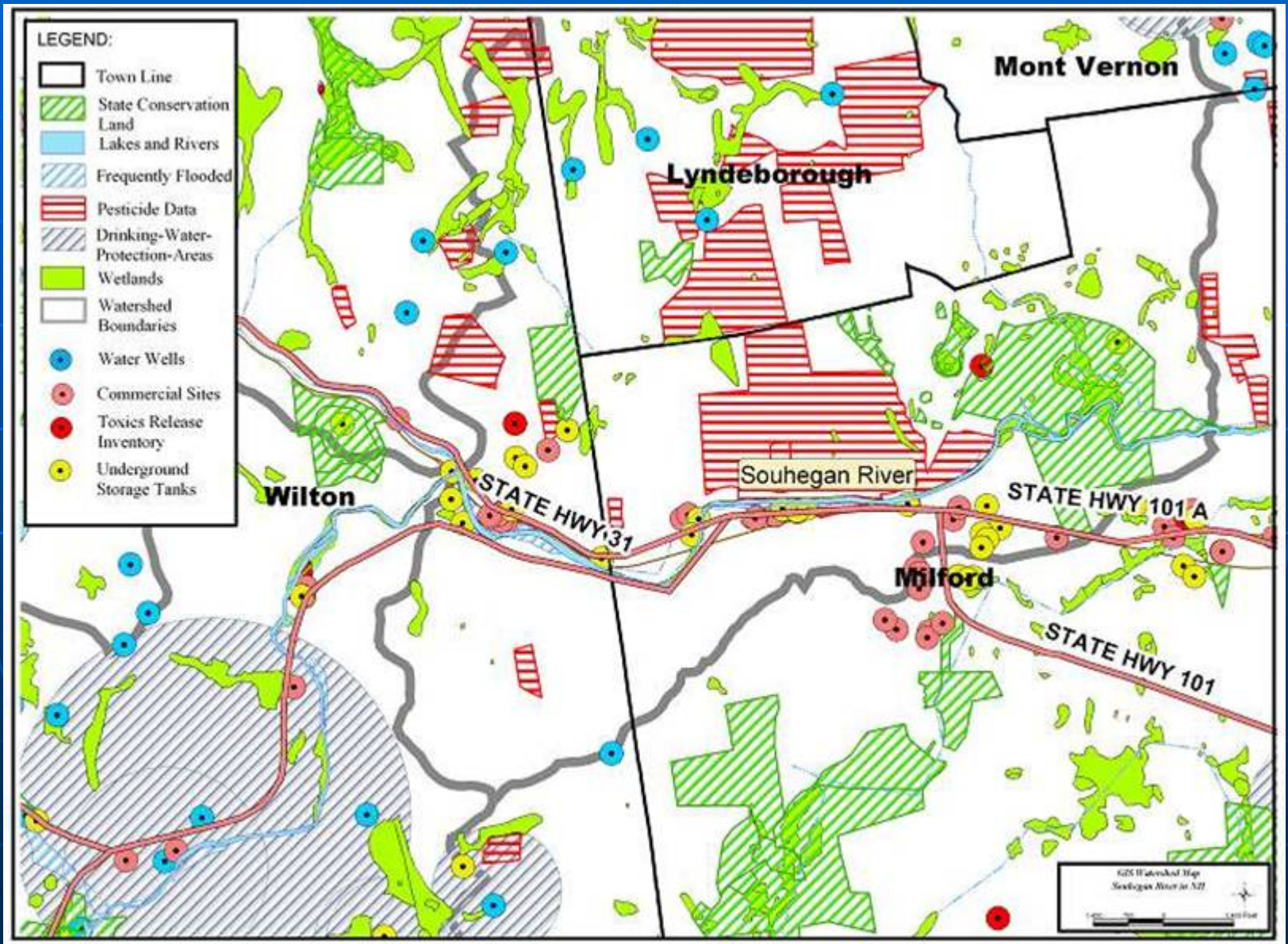


Task 4. Report Describing IPUOCR Entities and Proposed PISF Methods

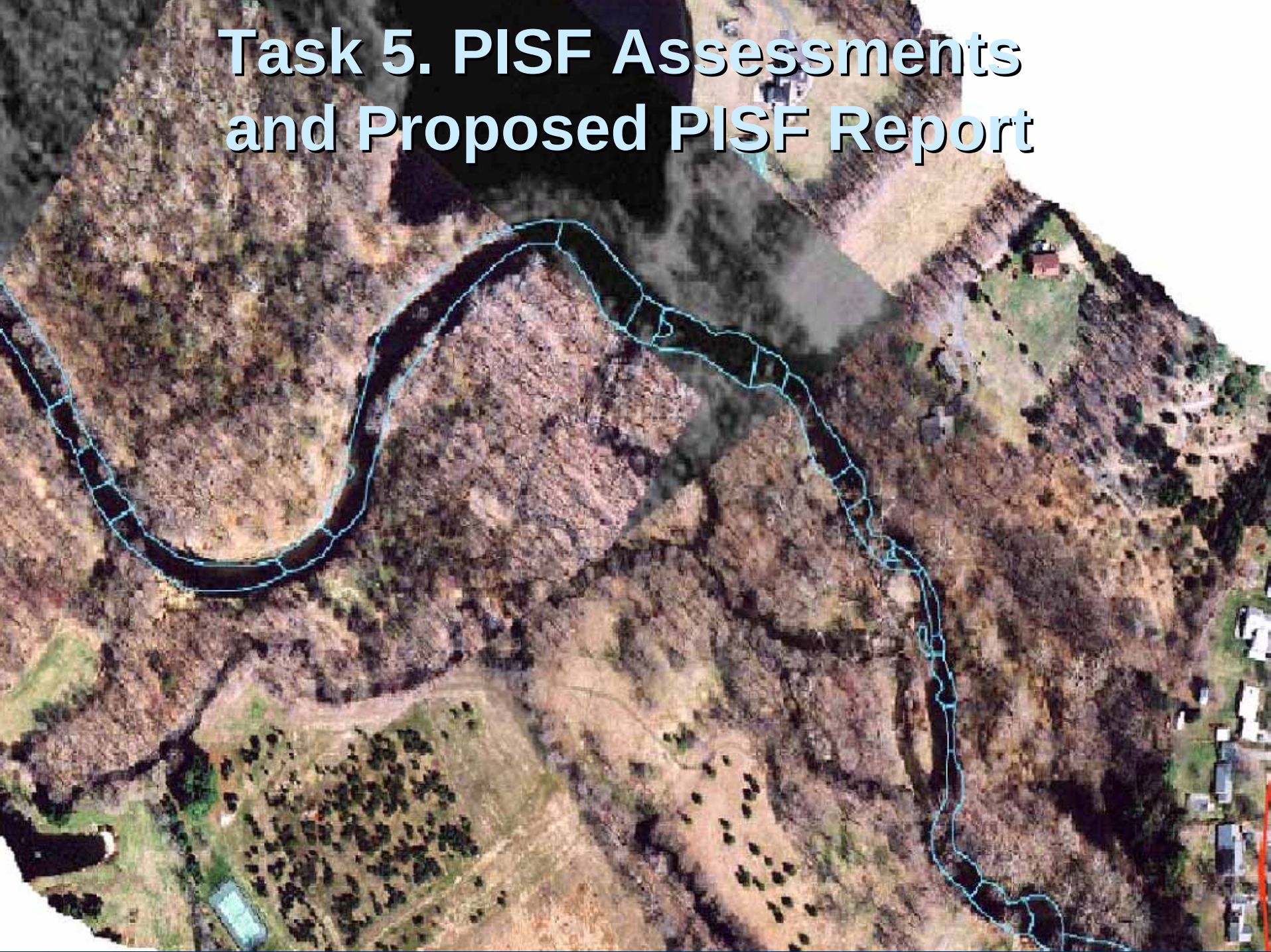
submitted October 1, 2004

http://www.unh.edu/erg/souhegan/

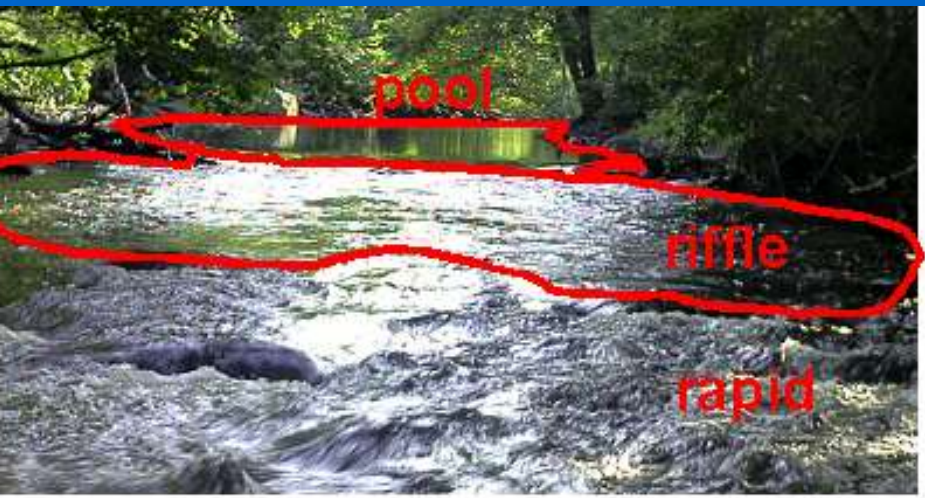
Presentation of IPUOCR Findings



Task 5. PISF Assessments and Proposed PISF Report

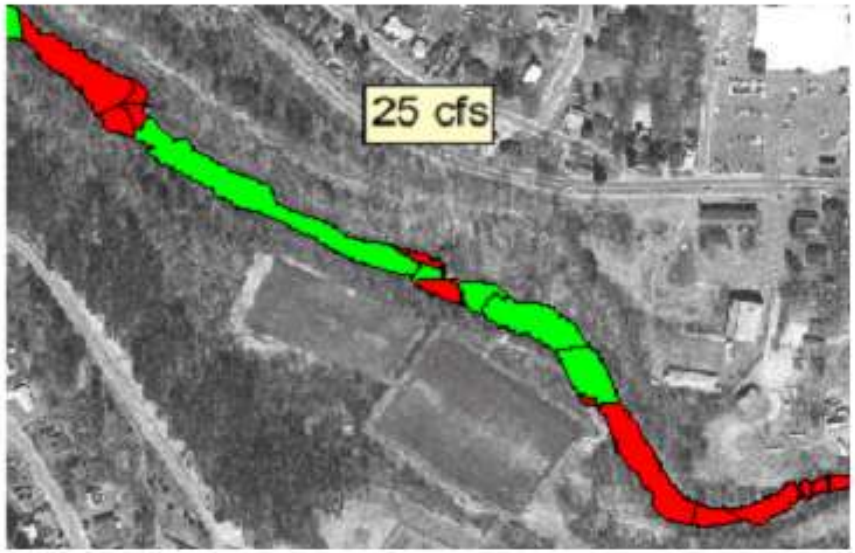


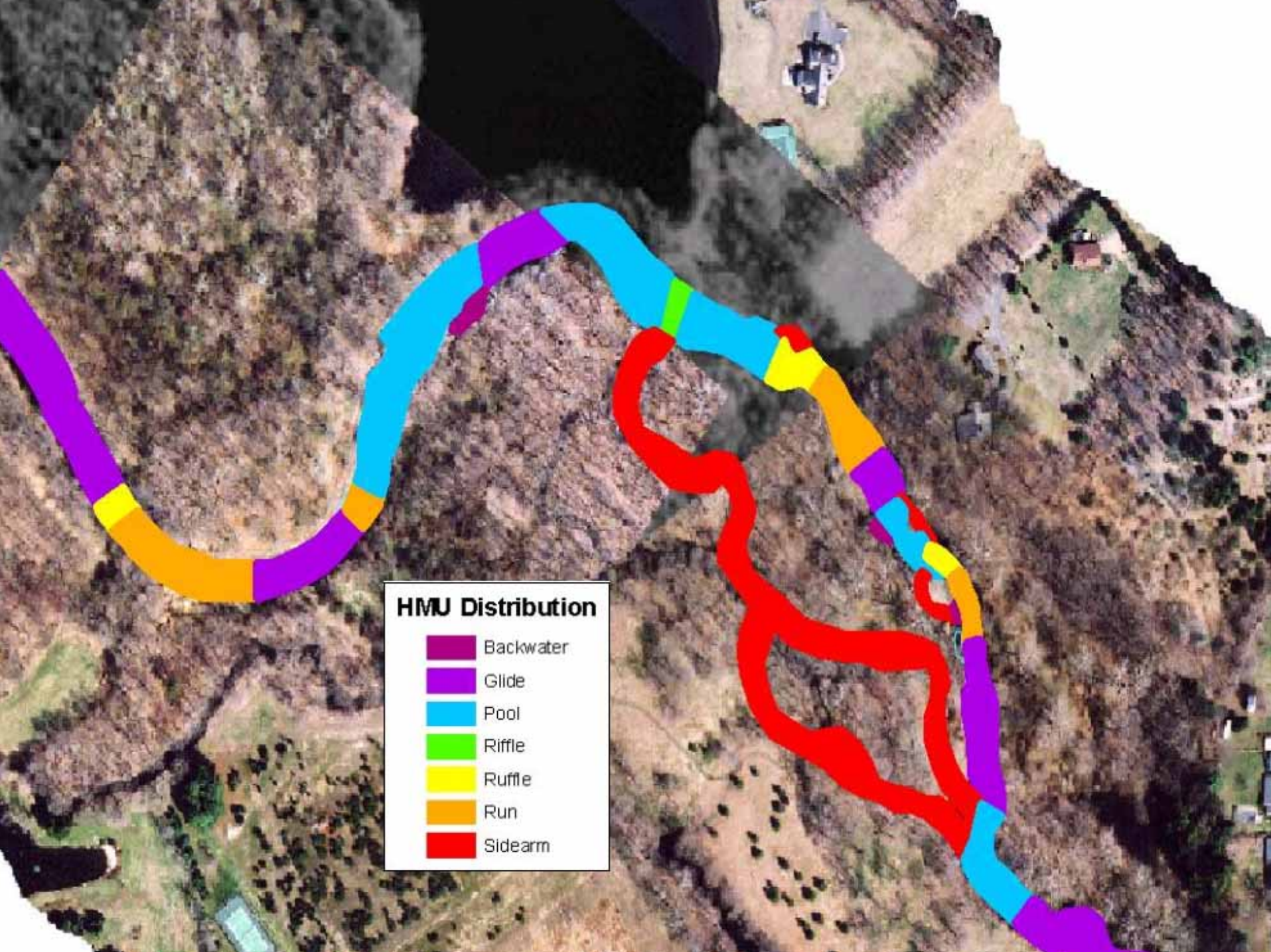
MesoHABSIM

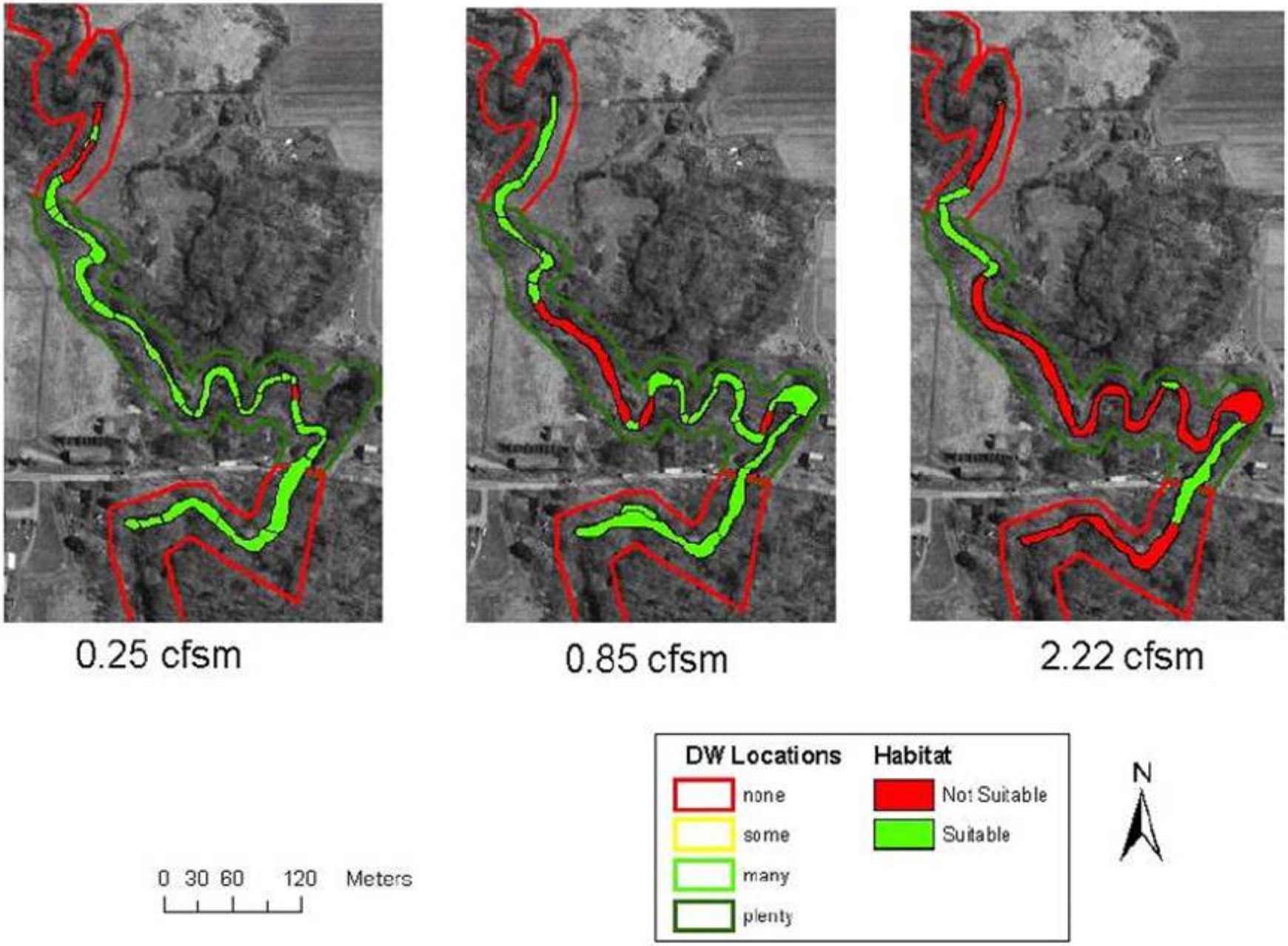


FALLFISH

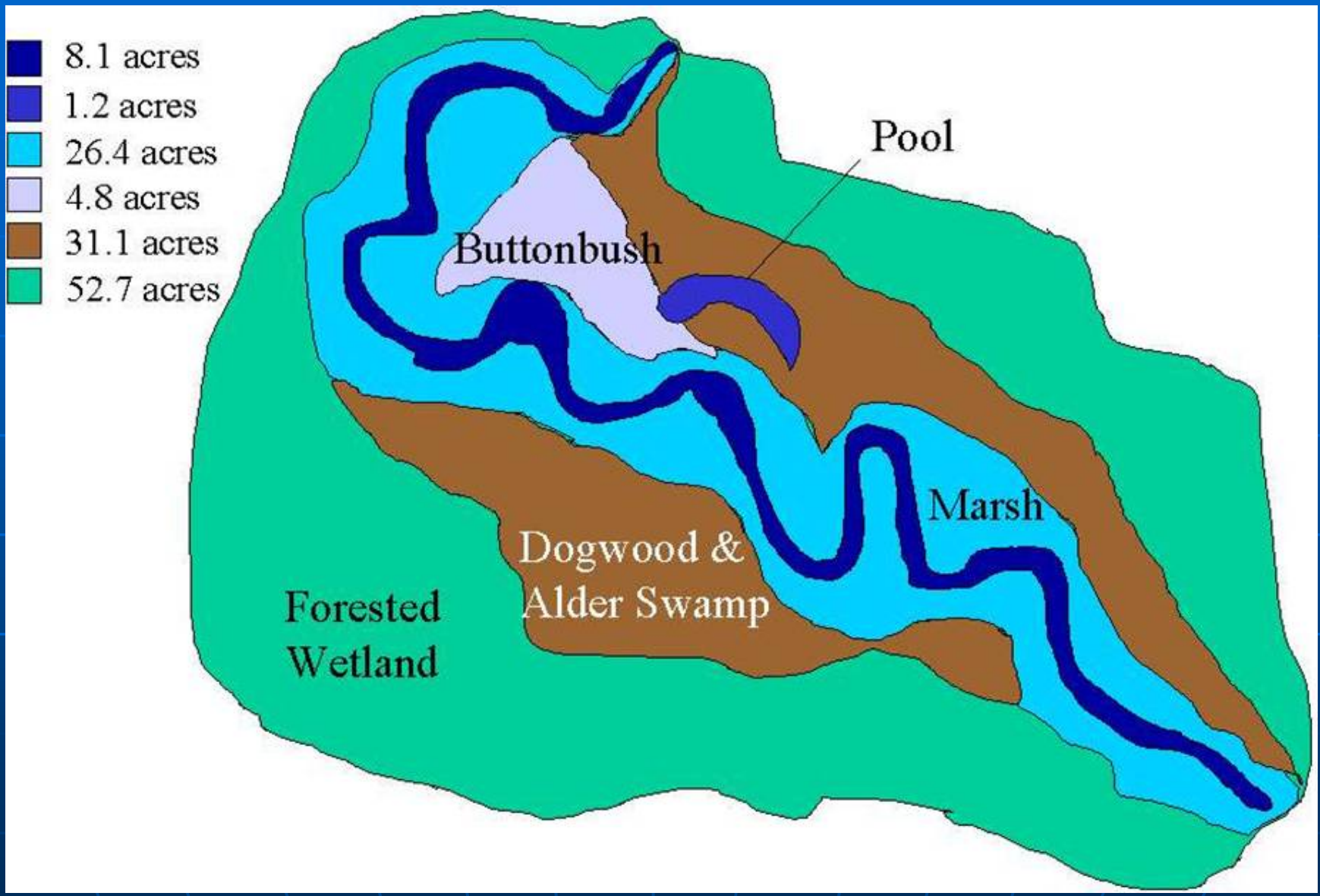
Presence (76%)		Beta
	BOULDER	1.95
	SHADING	-1.07
	DEPTH 0-25 cm	-1.76
	VELOCITY 45-60 cm/s	1.08
	RUN	-0.57
High abundance (60%)		
	Overhanging vegetation	-0.97




HMU Distribution
Backwater
Glide
Pool
Riffle
Ruffle
Run
Sidearm



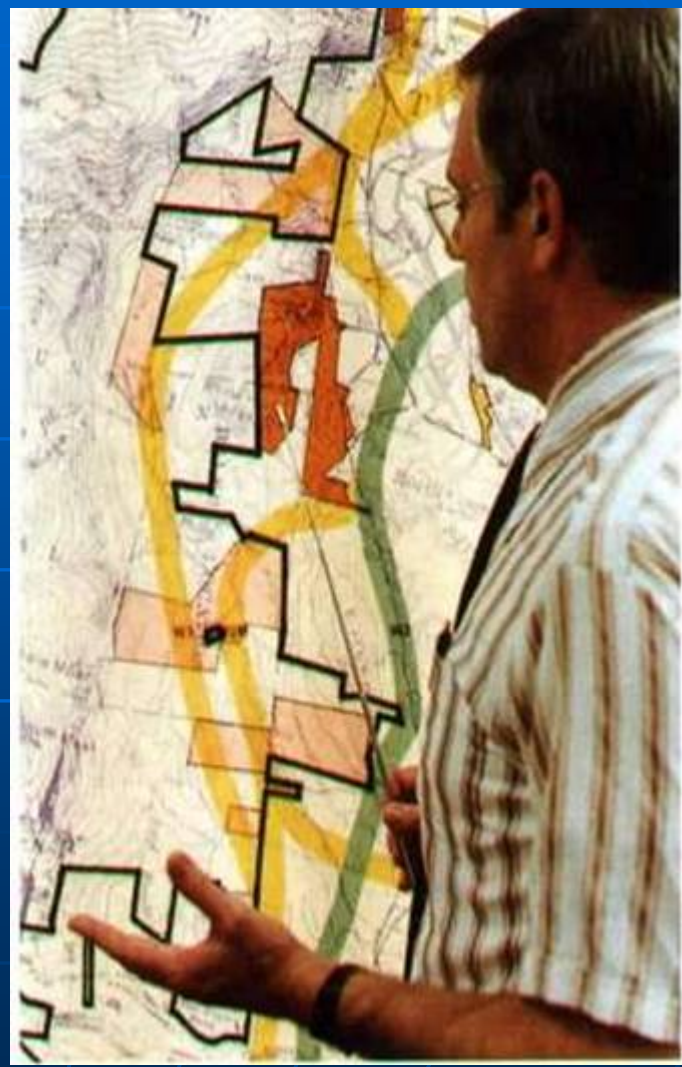
A3: 3. Relative suitable dwarf wedgemussel habitat at Site 2b depicting suitable and not suitable areas. The outline of the study site represents mussel locations in four different abundances.


8.1 acres
1.2 acres
26.4 acres
4.8 acres
31.1 acres
52.7 acres
Pool
Buttonbush
Marsh
Dogwood &
Alder Swamp
Forested
Wetland

Task 6: PISF Public Hearing

- Deliver Draft PISF Report
- Prepare Public Hearing Materials
- Update the DES Instream Flow Website
- Record Public Comments

Target Date: March 2006



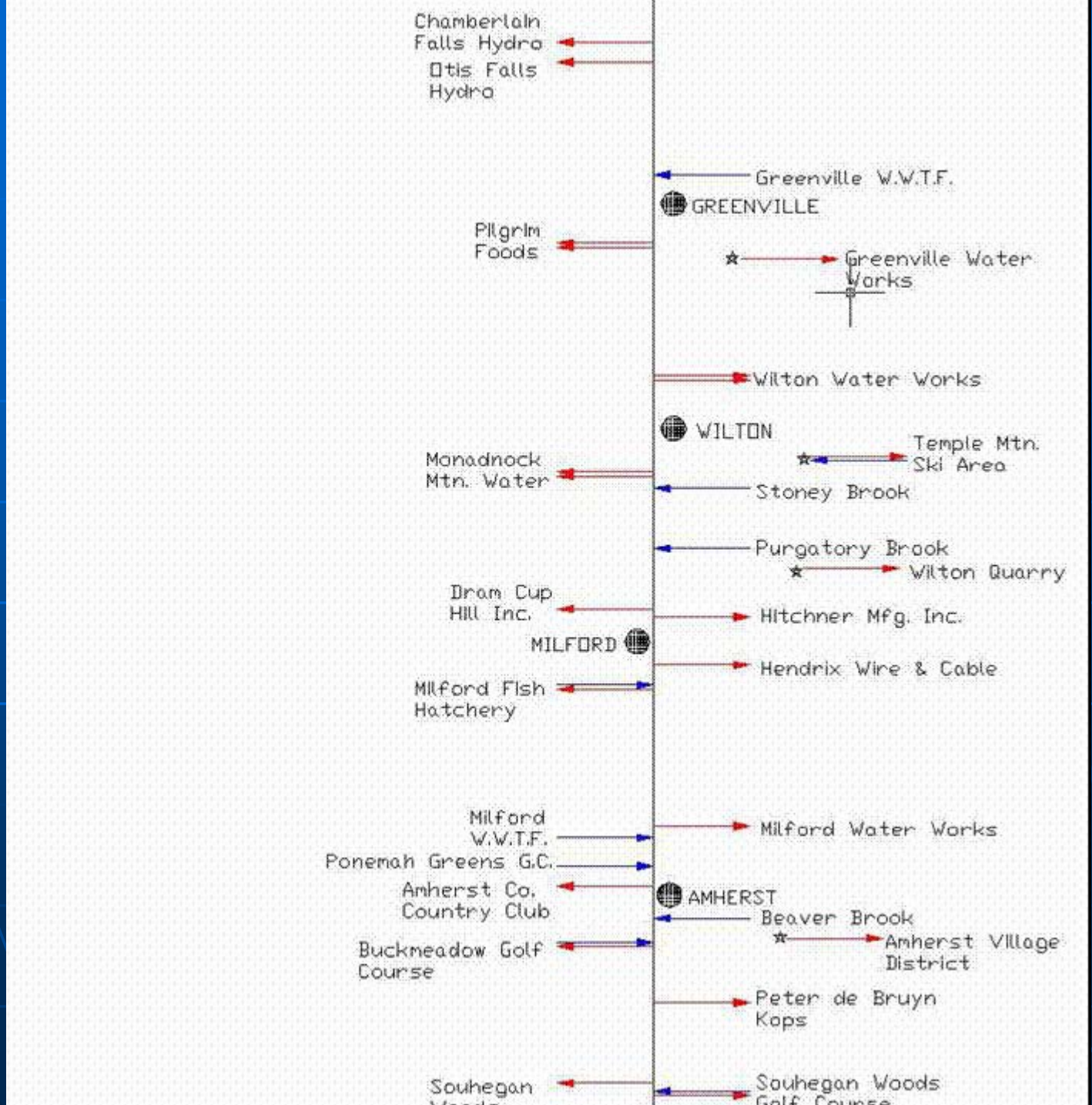
Task 7: PISF Final Report

- Review Public Comments
- Meet with DES to Review Responses
- Finalize PISF Report
- Add Public Comments Section

Task 8. Assessment of Water Use with the Established PISF

- River flow to be constructed along the Souhegan River for various non-exceedance probabilities
- Water uses and return flows quantified, located, and delineated.
- PISF identified at distinct river locations
- All data synthesized to reveal locations and flows when sections of the river cannot meet both PISF and demands

Site	Description	7Q10 (cfs)	Median August Flow (cfs)	0.5 cfsm (cfs)	0.1 Q_{avg} (cfs)	0.3 Q_{avg} (cfs)
SR6	Handicap Access Fish Ramp - Greenville	2.8	6.8	12.0	5.1	11.9
SR12	High Energy Bank - Greenville	3.1	7.6	13.6	5.7	13.4
SR16	Upstream of Monadnock Water	1.1	6.9	22.3	3.8	21.9
SR18	Intervale Road - Wilton	2.0	8.7	22.5	5.3	22.2
SR25	Wilton wastewater pumping station	4.2	13.8	29.7	9.4	29.3
SR31	Shopping Center Mall - Milford	4.0	18.3	48.8	11.2	48.0
SR34	Electric Substation - Milford	3.1	17.0	50.6	9.8	49.7
SR50	Boston Post Road - Amherst	5.2	23.5	61.5	14.4	60.5
SR56	Tomalison Farm - Amherst	5.3	24.4	64.5	14.9	63.4
SR62	Turkey Hill Road - Amherst	10.3	32.9	69.3	22.6	68.4
USGS	USGS Gage	13.0	41.0	85.7	28.2	84.6


Chamberlain Falls Hydro
Otis Falls Hydro
Greenville W.W.T.F.
GREENVILLE
Pilgrim Foods
Greenville Water Works
Wilton Water Works
WILTON
Temple Mtn. Ski Area
Monadnock Mtn. Water
Stoney Brook
Purgatory Brook
Wilton Quarry
Dram Cup Hill Inc.
Hitchner Mfg. Inc.
MILFORD
Hendrix Wire & Cable
Milford Fish Hatchery
Milford W.W.T.F.
Milford Water Works
Ponemah Greens G.C.
Amherst Co. Country Club
AMHERST
Beaver Brook
Amherst Village District
Buckmeadow Golf Course
Peter de Bruyn Kops
Souhegan
Souhegan Woods

Task 9. Development of WMP Sub-plans

- Conservation Plan
- Water Use Plan
- Dam Management Plan

Conservation Plan

- Identify AWUs
- Identify Water Use Types
  - Conservation Measures
  - BMPs
- Description of AWU
  - Characteristics
  - Flow
  - Pattern
  - Variability
  - History
  - Conservation Opportunities
  - Historic Conservation
  - BMPs
  - 5-year Plan
  - Economics
  - New Technologies
- Implementation Schedule
  - Description of Measures
  - Target Dates

ALL PERFORMED THROUGH MEETINGS AND DISCUSSIONS WITH EACH AWU

Water Use Plan

- AWU Water Use Data
- Potential Modifications
- Effect of PSIF on Hydropower
- Overall Water Use Plan
- Implementation Schedule
- Economic Assessment

ALL PERFORMED THROUGH MEETINGS AND DISCUSSIONS WITH EACH AWU

Dam Management Plan

- Individual ADO Information and Specifications
- Potential for Low Flow Augmentation/Regulation (Relative Reservoir Size)
- Downstream Ecologic Restrictions
- Operation Strategies to Meet PISF
- Implementation Schedule
- Economic Assessment

ALL PERFORMED THROUGH MEETINGS AND DISCUSSIONS WITH EACH ADO

Task 10. Proposed WMP

- Integration of Sub-Plans
- System-wide strategies
- MCDA of strategies
- Economic assessment for AWUs and ADOs
- Financial Assistance

Target Date: June 2006

Task 11. WMP Public Hearing

Task 12. WMP for the Souhegan River Designated Reach

WMPAAC Meetings

- 22 October 2004
  - Overview
  - MCDA

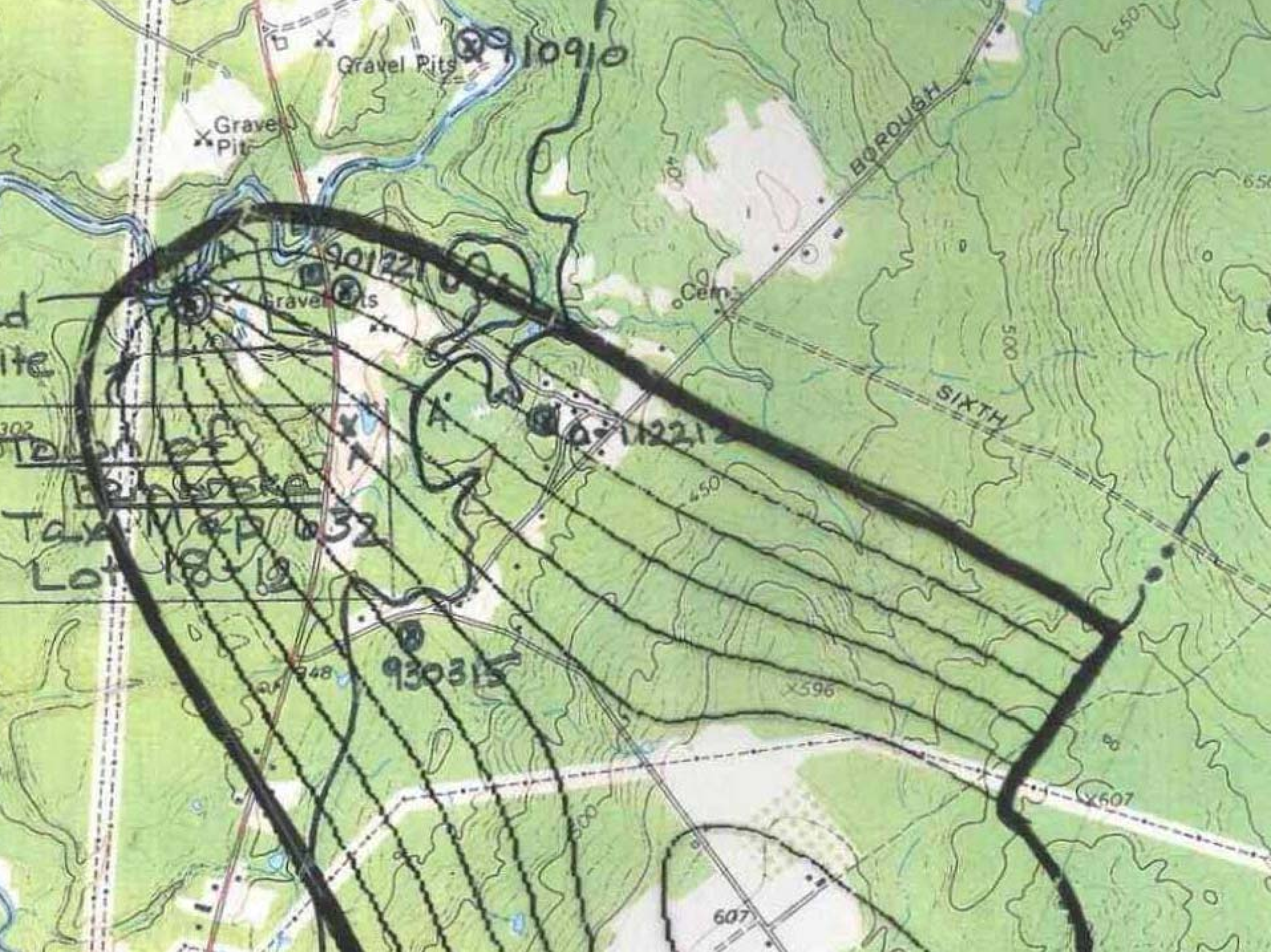
TRC Meetings

- 7 January 2005
  - IPUOCR Report
  - Task 2 Methods
  - CUT Curves
- 1 April 2005
  - Task 2 Analytical Results
  - Generic PISF Results and WMP
- 28 November 2005
  - Task 2 Field Results
  - TFC Results


NH
SOUHEGAN RIVER

Task 2. Assessment of Well Withdrawal Impacts on Surface Water

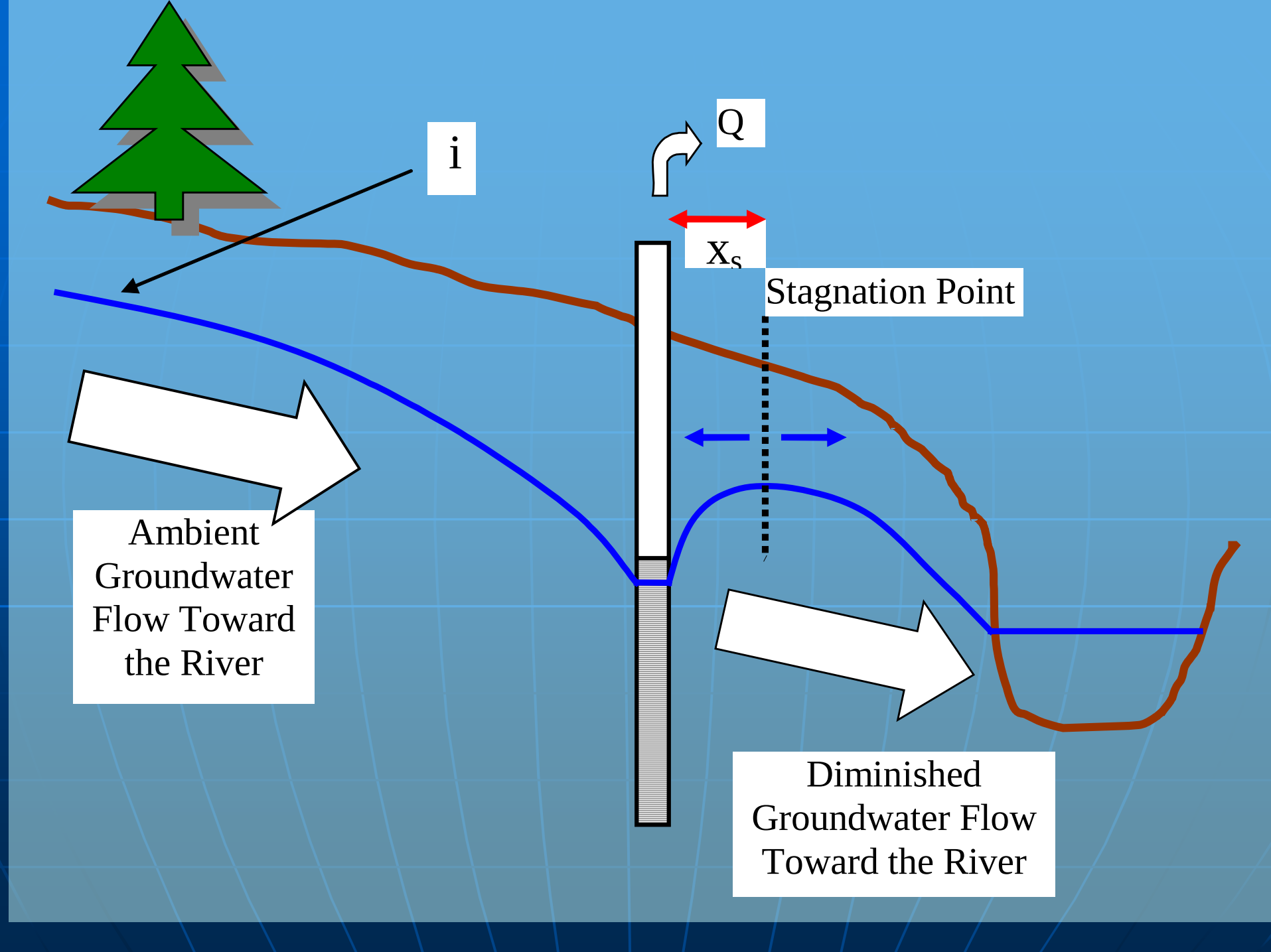
- Existing Well Head Protection and Aquifer Studies
- Analytical Techniques
- Field Monitoring



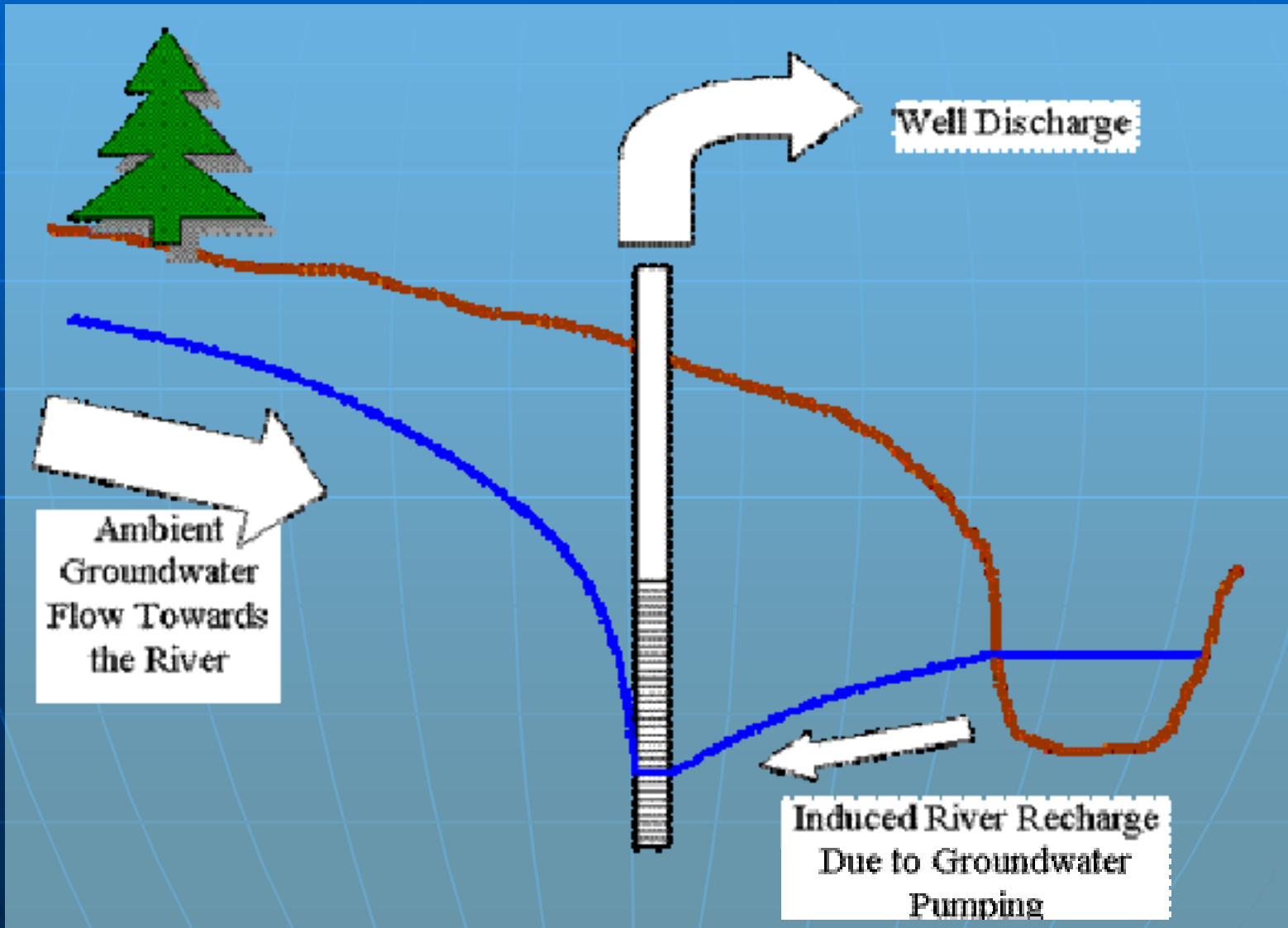
Gravel Pits
Gravel Pit
Gravel Pits
BOROUGH
Cem
SIXTH
91109
901221
921221
930315
Town of
Pembroke
Tax Map 632
Lot 18-12
A
A'
550
650
500
450
596
607
607

Analytical Techniques

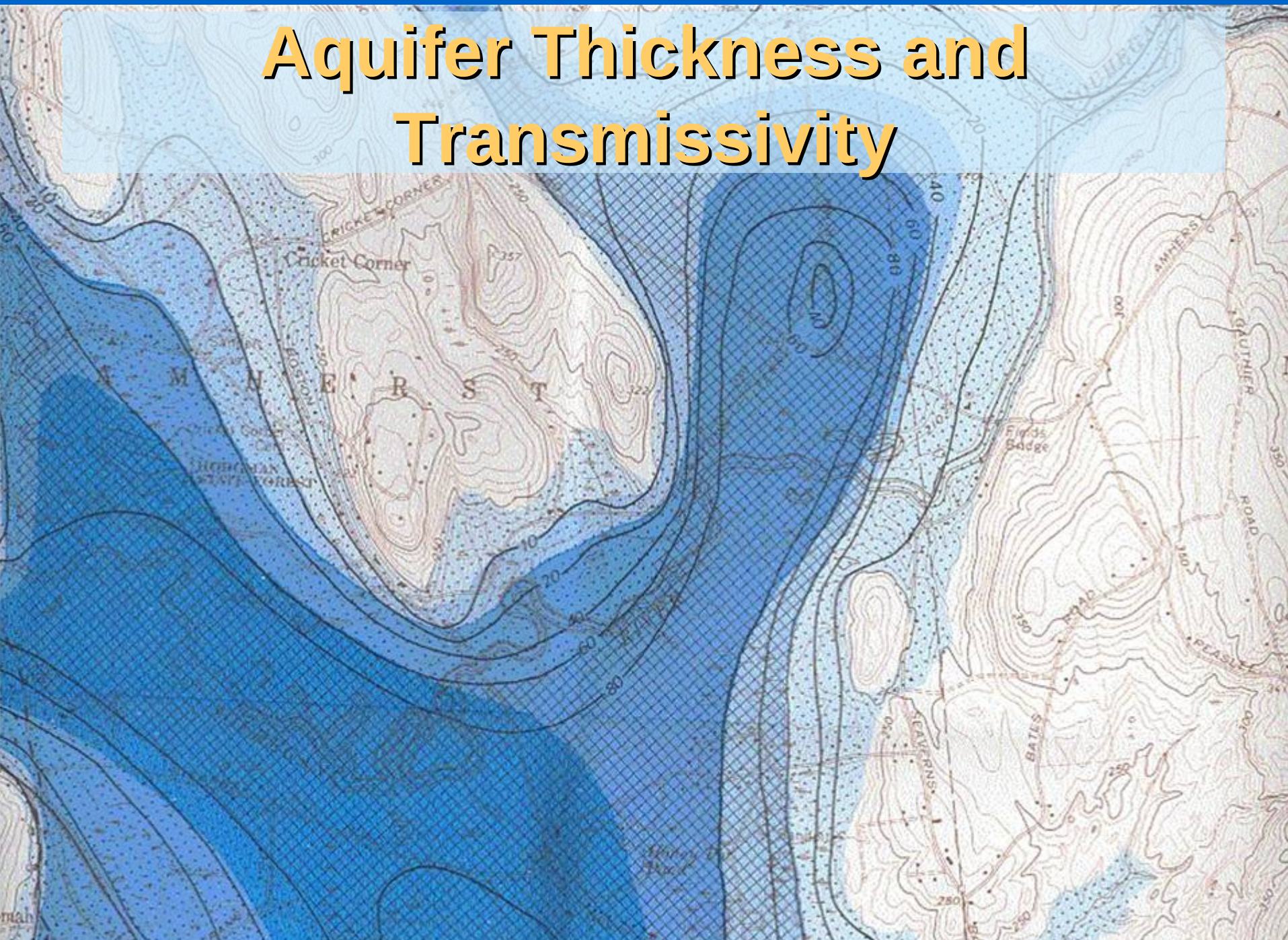
- Steady State Equations
- Groundwater Models


i
Q
x_s
Stagnation Point
Ambient Groundwater Flow Toward the River
Diminished Groundwater Flow Toward the River

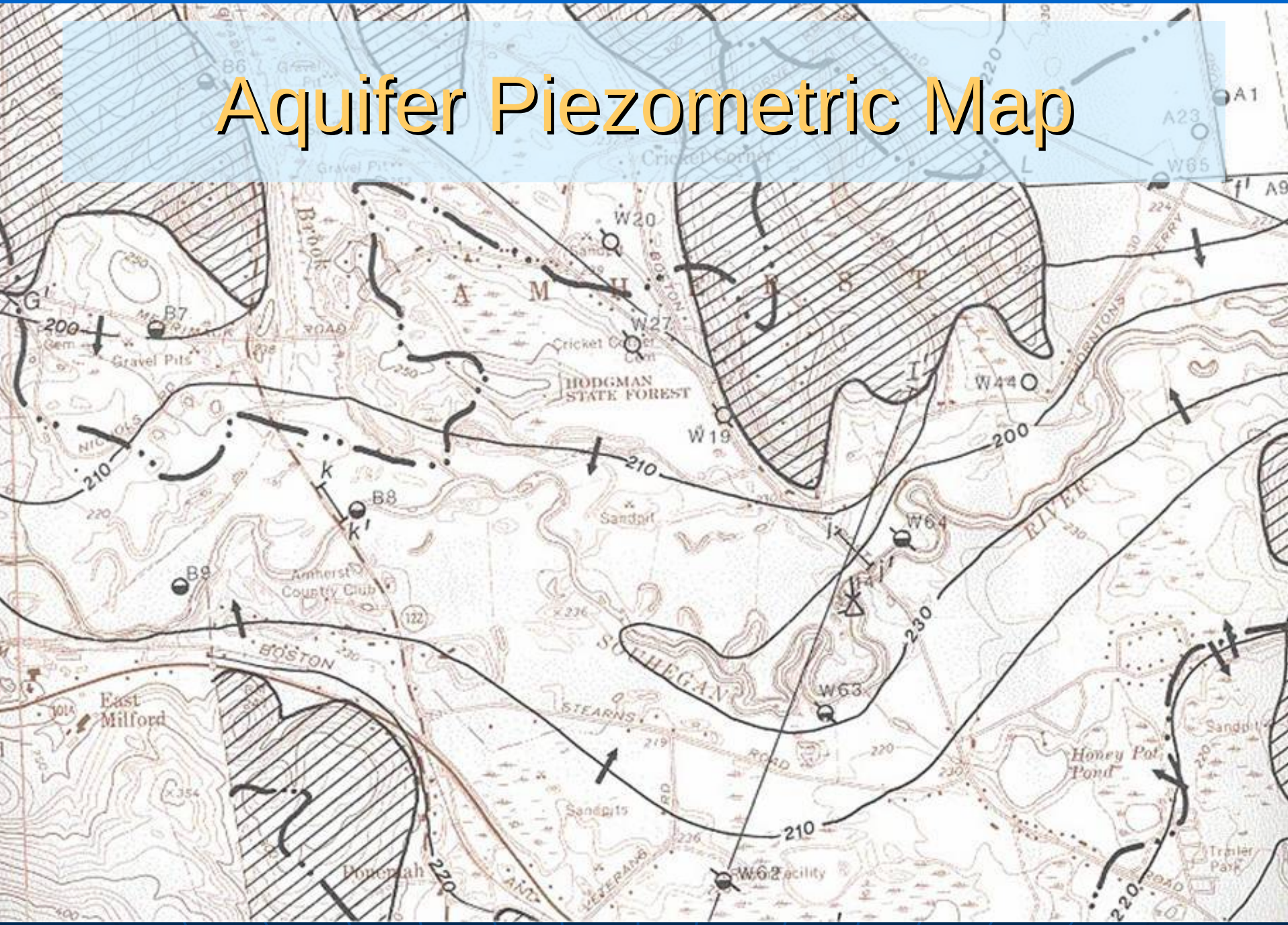
Effect of Increasing the Quantity of Groundwater Withdrawals



Aquifer Thickness and Transmissivity



Aquifer Piezometric Map



Well Owner	Well
AMHERST COUNTRY CLUB	IRRIGATION
BUCKMEADOW GOLF CLUB	GOLF COURSE
MILFORD WATER WORKS	CURTIS WELL #1
MILFORD WATER WORKS	CURTIS WELL #2
MONADNOCK MOUNTAIN WATER	MANSUR ROAD SPRING WELL
MONADNOCK MOUNTAIN WATER	MANSUR ROAD WELL #2
MONADNOCK MOUNTAIN WATER	MANSUR ROAD WELL #3
MONADNOCK MOUNTAIN WATER	INTERVALE ROAD WELL
NH FISH & GAME	WELL #4 RIVER WELL
NH FISH & GAME	WELL #1 FIELD WELL
PENNICHUCK WATER WORKS	AMHERST VILLAGE DISTRICT
PENNICHUCK WATER WORKS	SOUHEGAN WOODS
PETER DE BRUYN KOPS	IRRIGATION
PILGRIM FOODS	SOUHEGAN RIVER WELL
PILGRIM FOODS	ON SITE WELL - Water Tower
PILGRIM FOODS	ON SITE WELL - Parking Lot
PONEMAH GREEN GOLF COURSE	IRRIGATION
SOUHEGAN WOODS GOLF CLUB	GOLF COURSE
WILTON WATER WORKS	EVERETT WELL ROUTE 31
WILTON WATER WORKS	ABBOTT WELL ROUTE 31

Well ID	Distance to River (ft)	Land Slope	Groundwater Slope	Transmissivity (sq. ft./day)
A	-	0.037	0.05	6,000
B	84	0.031	0.016	3,000
C	529	0.036	0.02	2,000
D	110	0.01	0.01	8,000
E	99	0.019	0.0133	2,000
F	75	0.055	0.009	1,000
G	994	-	-	-
H	306	-	-	-
I	273	0.006	0.0114	8,000
J	140	0.006	0.011	1,000
K	100	-	-	-
L	89	0.031	0.016	3,000
M	92	0.0005	0.032	6,000
N	849	0.013	0.02	6,000
O	97	0.015	0.01	8,000
P	213	0.015	0.02	8,000
Q	74	0.015	0.01	8,000
R	110	0.01	0.01	8,000
S	316	-	-	-
T	668	0.0129	0.0017	8,000

Well ID	Maximum Reported Average Well Discharge (1,000 gal/day)	Max Flow Stagnation Distance (ft)	2000-2004 Reported Average Well Discharge (1,000 gal/day)	Avg Flow Stagnation Distance (ft)	Actual Distance (ft)
A	0	0.0	0	0.0	-
B	31.0	13.7	20.0	8.9	84
C	62.0	33.0	39.8	21.2	529
D	0	0.0	0	0.0	110
E	111	88.8	41.5	33.2	99
F	20.8	49.2	10.6	25.1	75
G	0	0.0	0	0.0	994
H	0	0.0	0	0.0	306
I	2139	499.0	1701	396.9	273
J	0	0.0	0	0.0	140
K	0	-	0	-	100
L	31.0	13.7	20.0	8.9	89
M	156	17.3	37.5	4.2	92
N	312	55.3	96.0	17.0	849
O	215	57.2	96.5	25.7	97
P	700	93.1	470	62.5	213
Q	700	186.2	470	125.0	74
R	0	0.0	0	0.0	110
S	0	0.0	0	0.0	316
T	1656	2590.8	851	1331.4	668

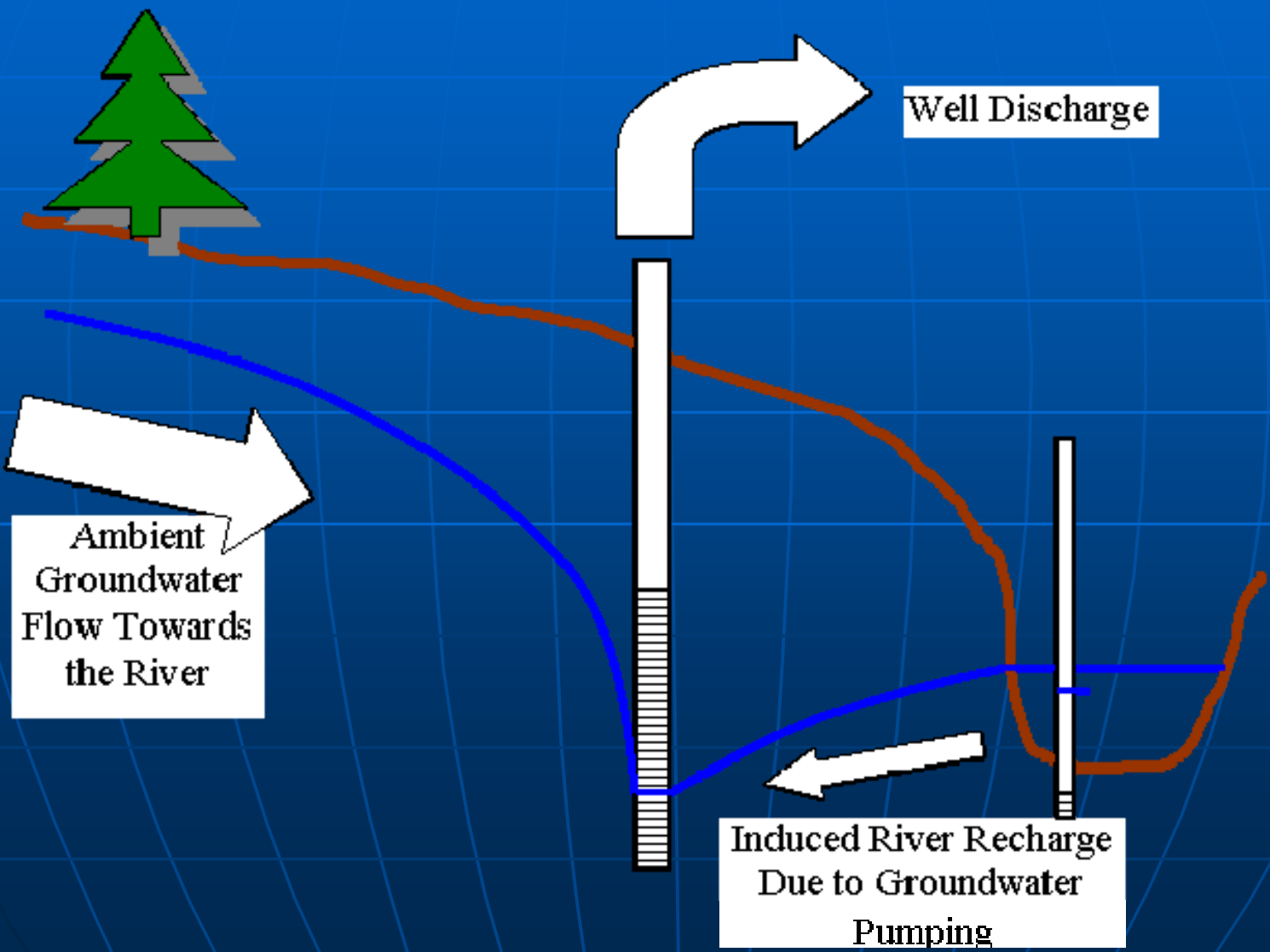
Well ID	2000-2004 Reported Average Well Discharge (1,000 gal/day	Flow to Achieve Stagnation at River (1,000 gal/day)	Possible Average Flow Reduction (1,000 gal/day)
I	1,701	1,170	531
Q	470	278	192
T	851	427	424

The preceding were the results of numerical estimates (office techniques)

Field Techniques

- Pumping Tests
- Monitoring
- Miniature Piezometers
- Seepage Flux Meters
- Tracer Tests

Field Measurements – Miniature Piezometers or Wells

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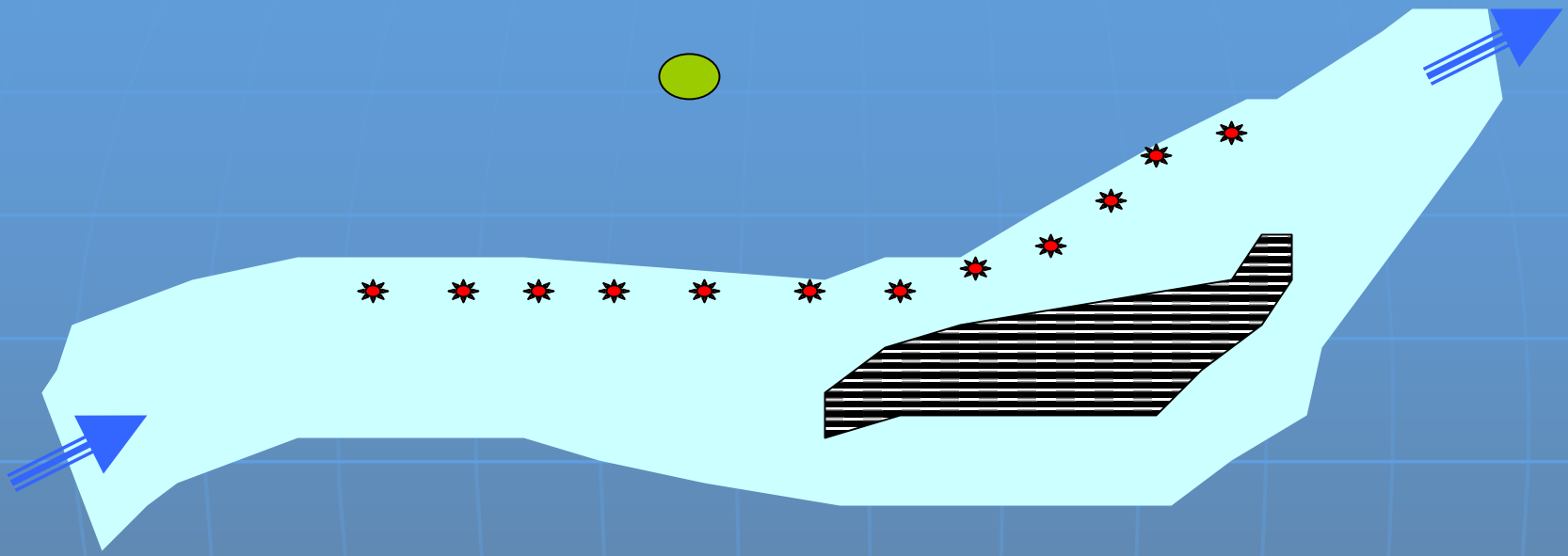

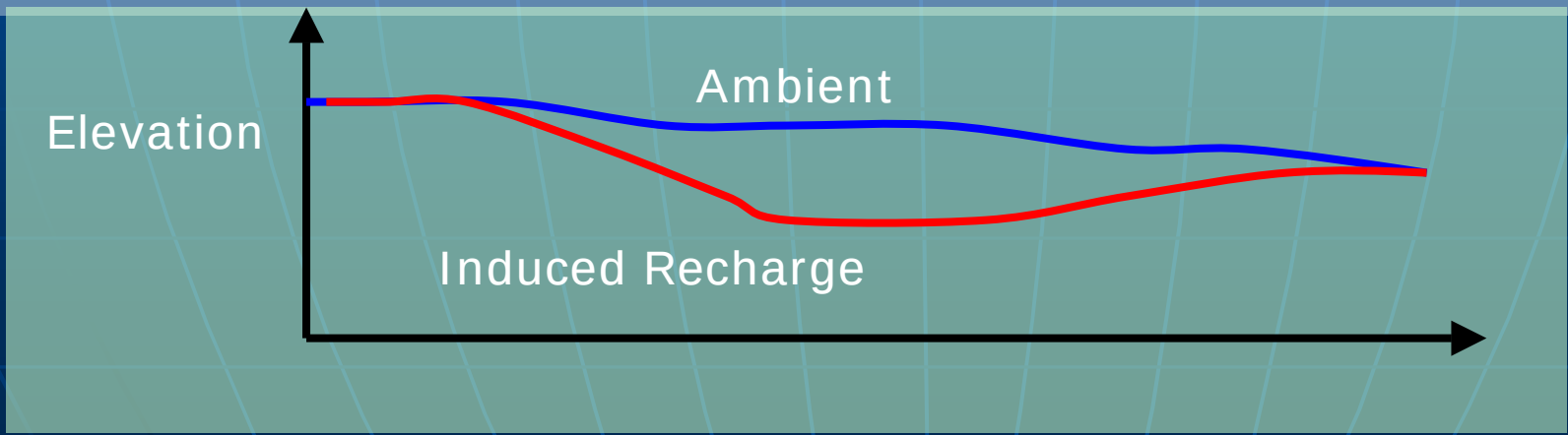
Elevation
Ambient
Induced Recharge

Field-Measured Vertical Gradients
(negative indicates downward flow)

Well ID	Horizontal Groundwater Slope (USGS Maps)	Max. Vertical Groundwater Slope (Field)	Upstream Distance to Ambient Slope (ft)	Upstream Distance to Ambient Slope (ft)
B	0.016	0.067	0	0
I	0.0114	-1.74	400	800
L	0.016	0.067	0	0
P	0.02	-1.00	300	900
Q	0.01	-1.00	300	900
T	0.0017	-1.74	400	800

Wells I, Q, and T were predicted to exhibit induced recharge. Well P is very close to well Q. The field data verified the numerical predictions.

END